

Incorporating Institutions into Bio-Economic Models of Sustainable Intensification

Kimberly Swallow and Brent Swallow

**Workshop on the “BioSight/Sustainable Futures” Project
IFPRI Headquarters & St. Gregory Hotel, Washington, DC
3-5 December, 2013**



Source: WorldFish



Source: ILRI

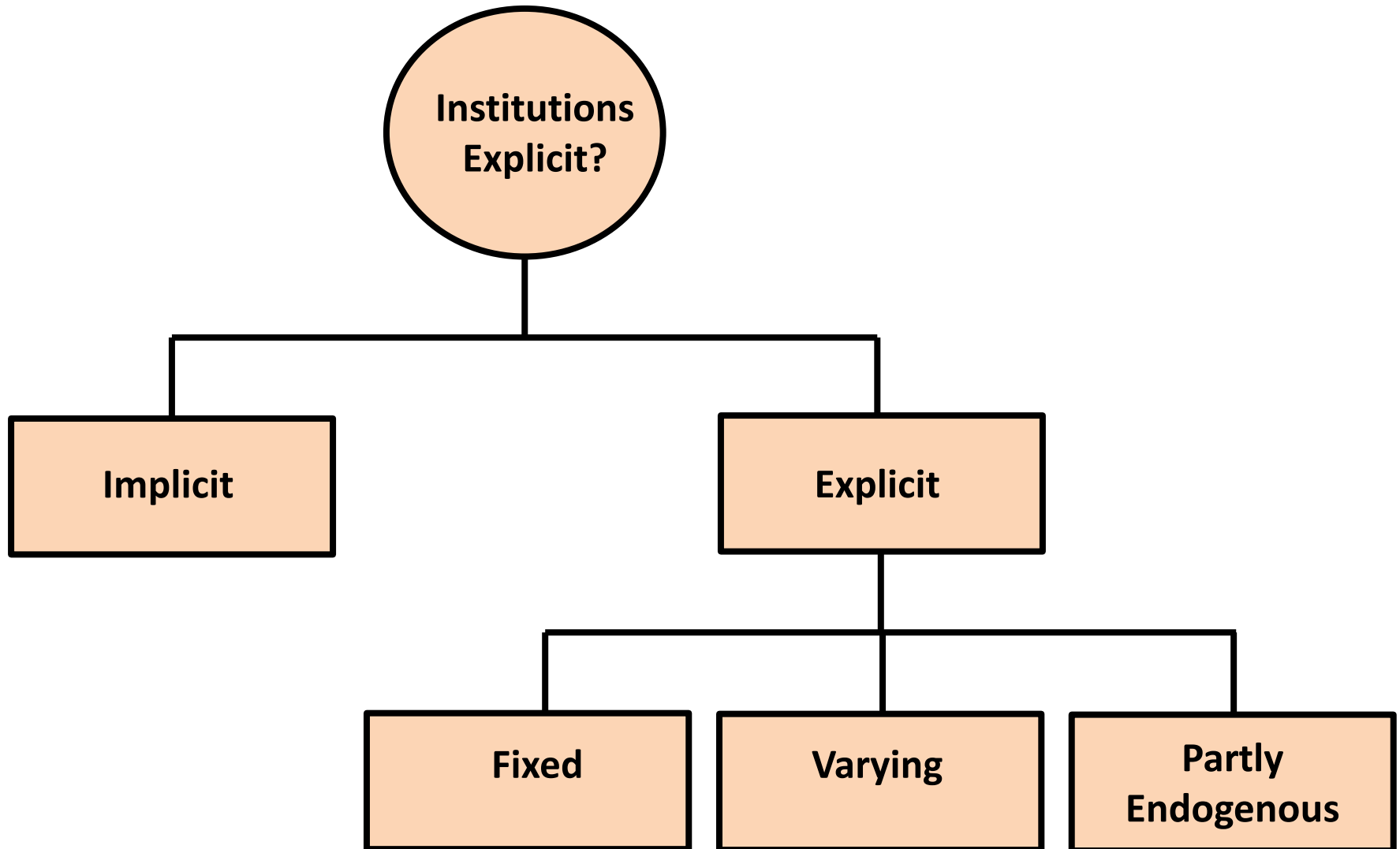


Source: ICRAF

Outline

- **What?: Institutions**
- **Why?: Problem Setting**
 - **Development Context**
 - **Sustainable Intensification**
- **How?: Integrating Institutions into Bio-Economic Models**
 - **Conceptual Framework**
 - **Types of Models**
 - **12 Examples**
 - **Approaches & Tradeoffs**
- **Conclusions: Best Practice**

Fig. 1 Approaches to Integrating Institutions into Bio-Economic Models



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Institutions

- **Definition:**
 - formal laws and informal rules that define expectations in transactions
- **Governance Bodies:**
 - Choose, monitor & enforce
- **Costs**
- **Benefits:**
 - Provide incentives and constraints on behavior
 - Provide the context of production and exchange

Context of Production & Exchange

- **Rights & Distribution of Bargaining Power in Strategic Interactions**
- **Define Transactions, esp. t-costs (I.C.E.)**
- **Market & Non-Market (Governed) Contexts**
- **Imperfections: Who Bears the Costs?**
 - **Informational Asymmetries**
 - **Transactions Costs**
 - **Externalities**

Fig. 2 CAPRI: Scale Factors & Institutions

(Source: Adapted from Knox, Meinzen-Dick and Hazell, 2002)

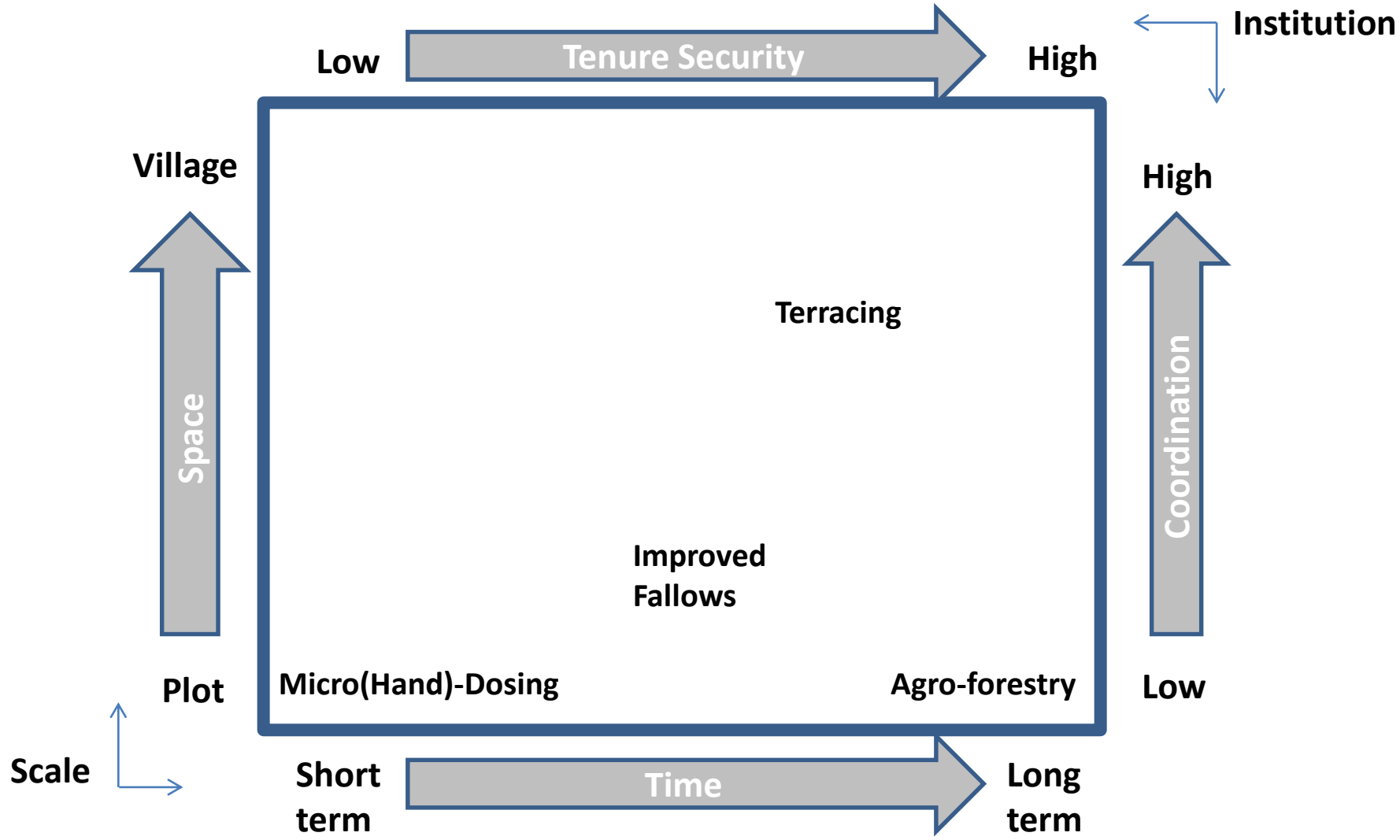


Fig. 3 Linkages:
Interactions/Externalities Within and Between Sectors
 (Source: Adapted from Msangi 2013)

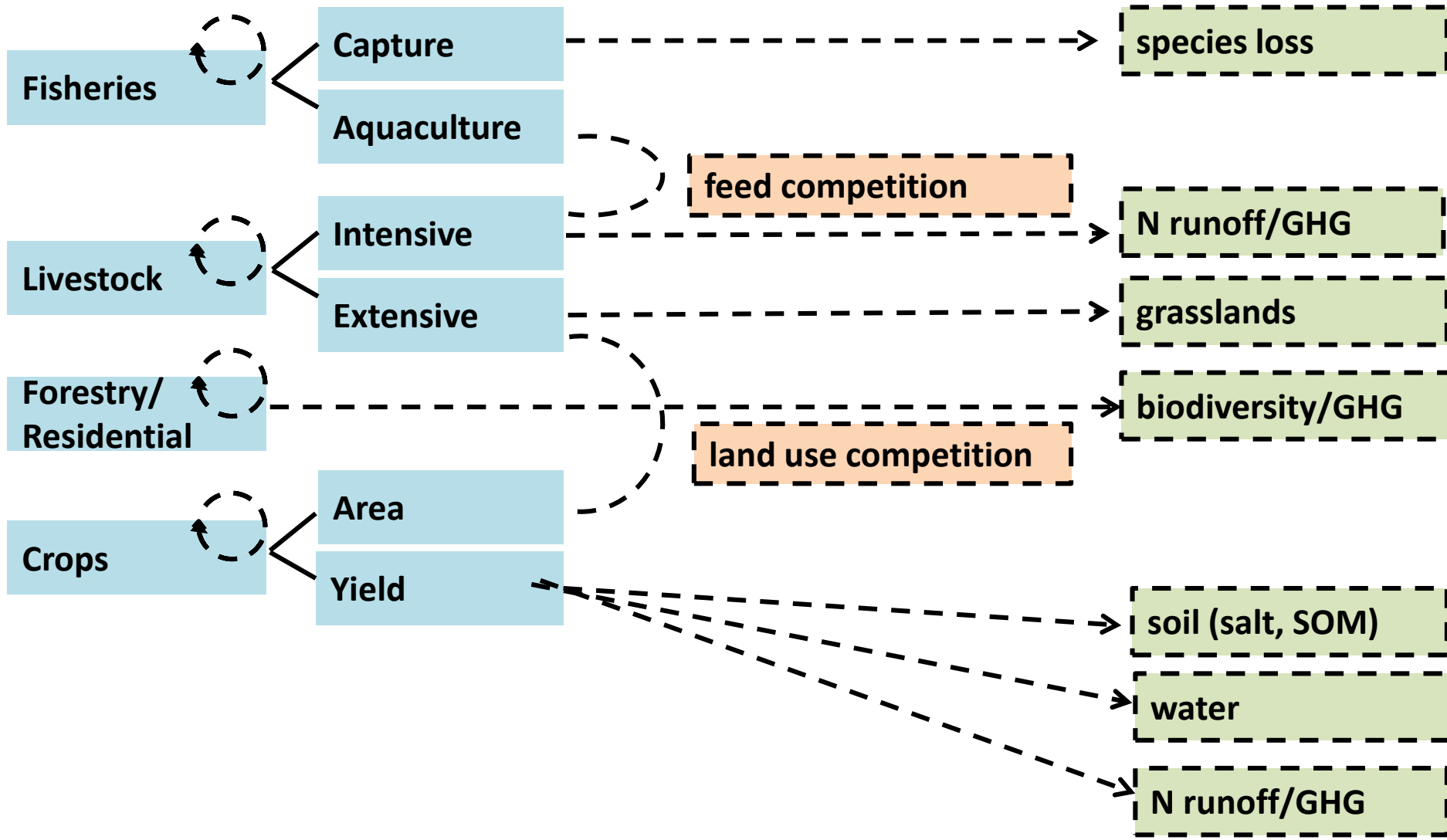
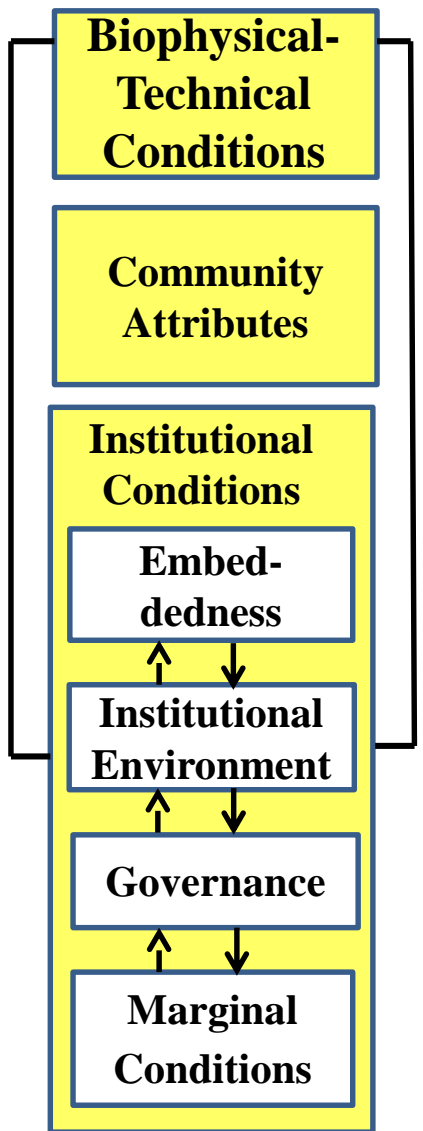


Fig. 4 (Biophysical) Techno-Institutional Unit

(Sources: Adapted from Ostrom and Cox, 2010; Williamson, 2000)



Key:
→ =outputs
- → =feedbacks and user learning

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Institutional Implications of Stage of Development

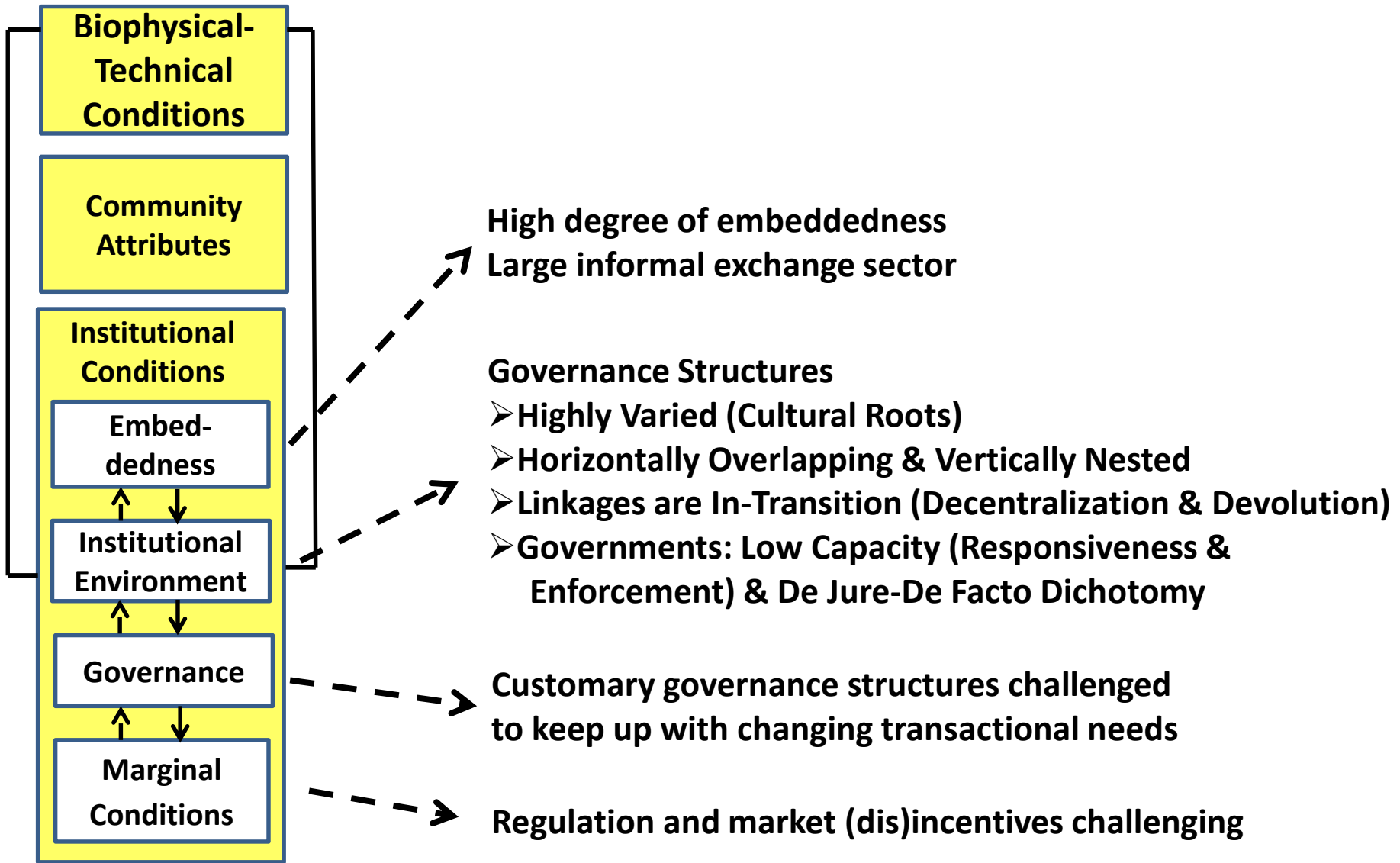
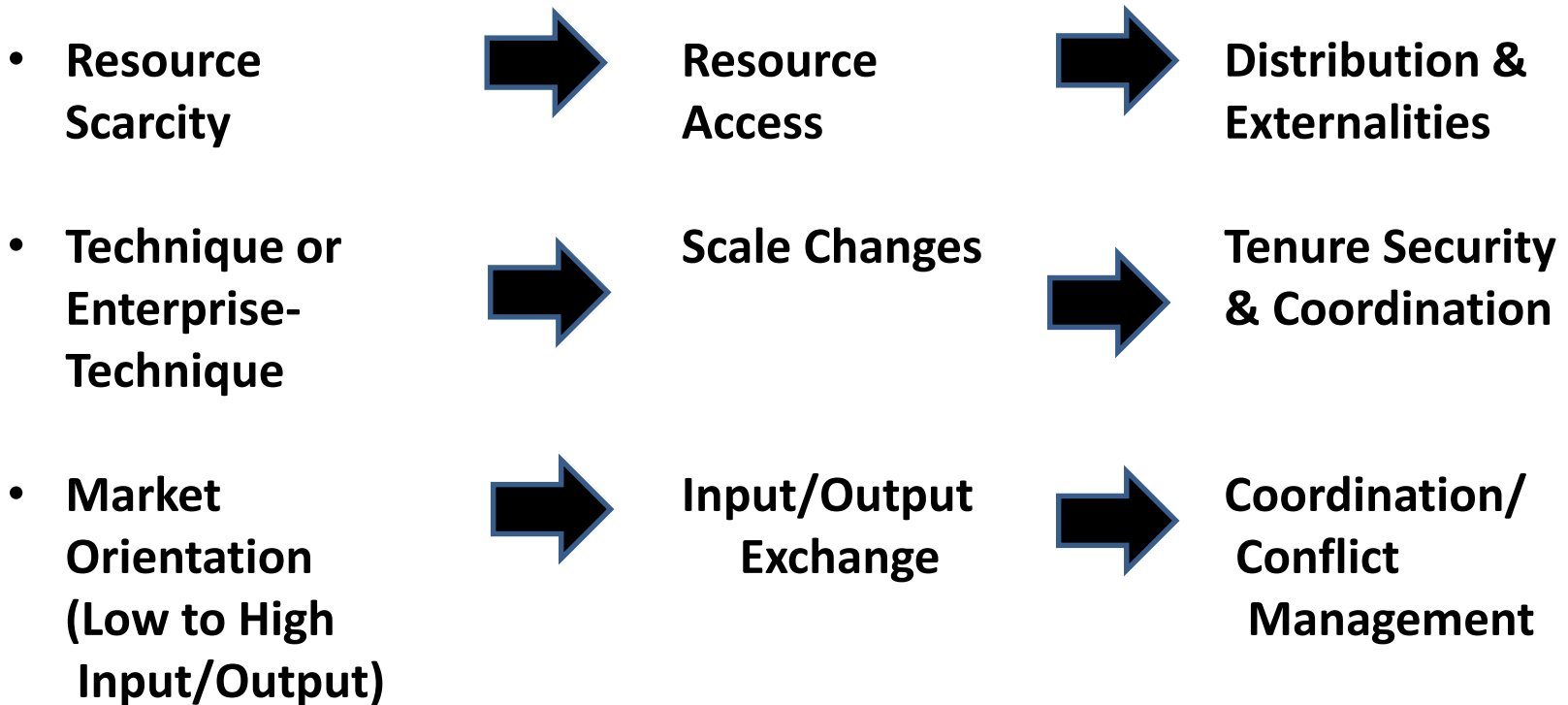
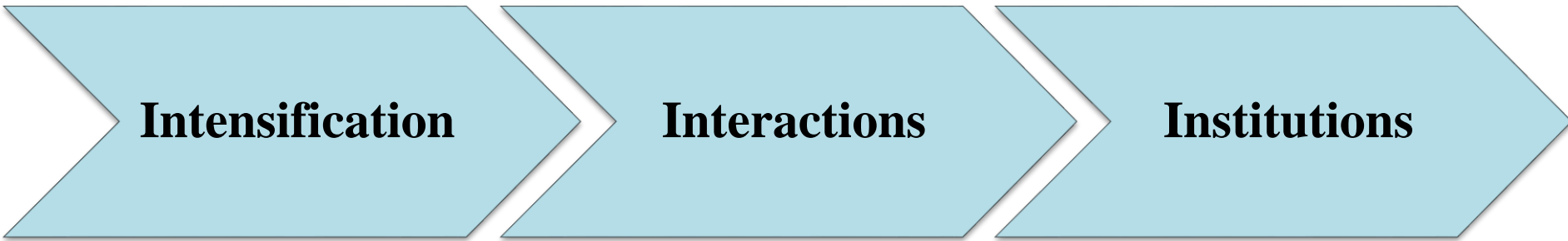



Fig. 5 Institutional Implications of Sustainable Intensification



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Key Elements of a Bio-Economic Model

- **Options**
 - **Resources/Types of Capital**
 - **Activities & motivations**
 - **Constraints**
- **Operational Units**
- **Interactions**
- **Outcomes**

- **Impact Pathways & Externalities**
- **Exogenous & Stochastic Events**
- **Feedbacks & Learning**

- **Governance Units**



Institutions:

- **Property rights**
- **Market exchange**
- **Intra-household allocation**
- **Social networks**
- **Collective action**
- **Policies**

Fig. 7 Bio-Econ. Institutional Framework

(Sources: Adapted from Ostrom and Cox, 2010; Williamson, 2000)

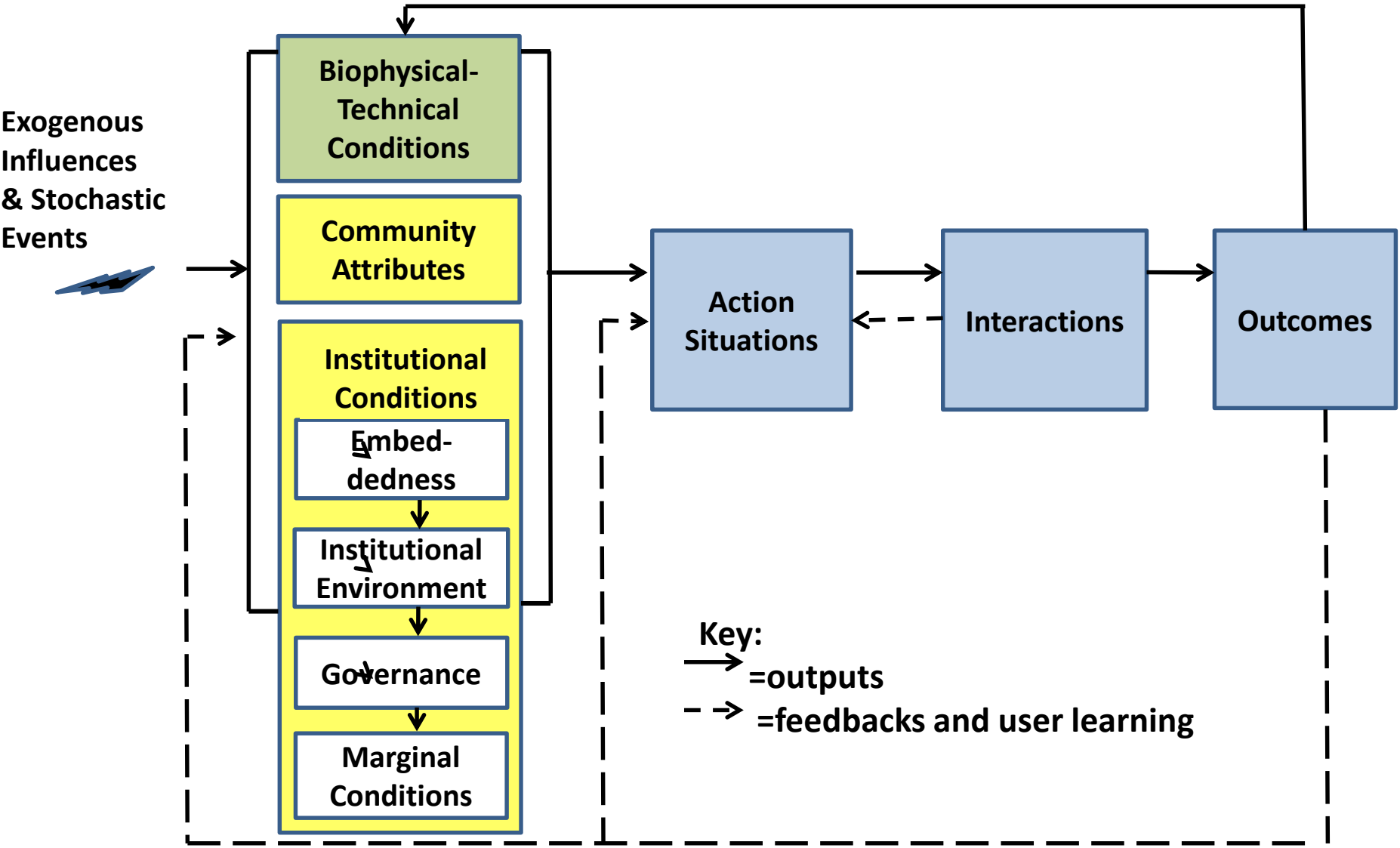


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Exogenous Influences & Stochastic Events

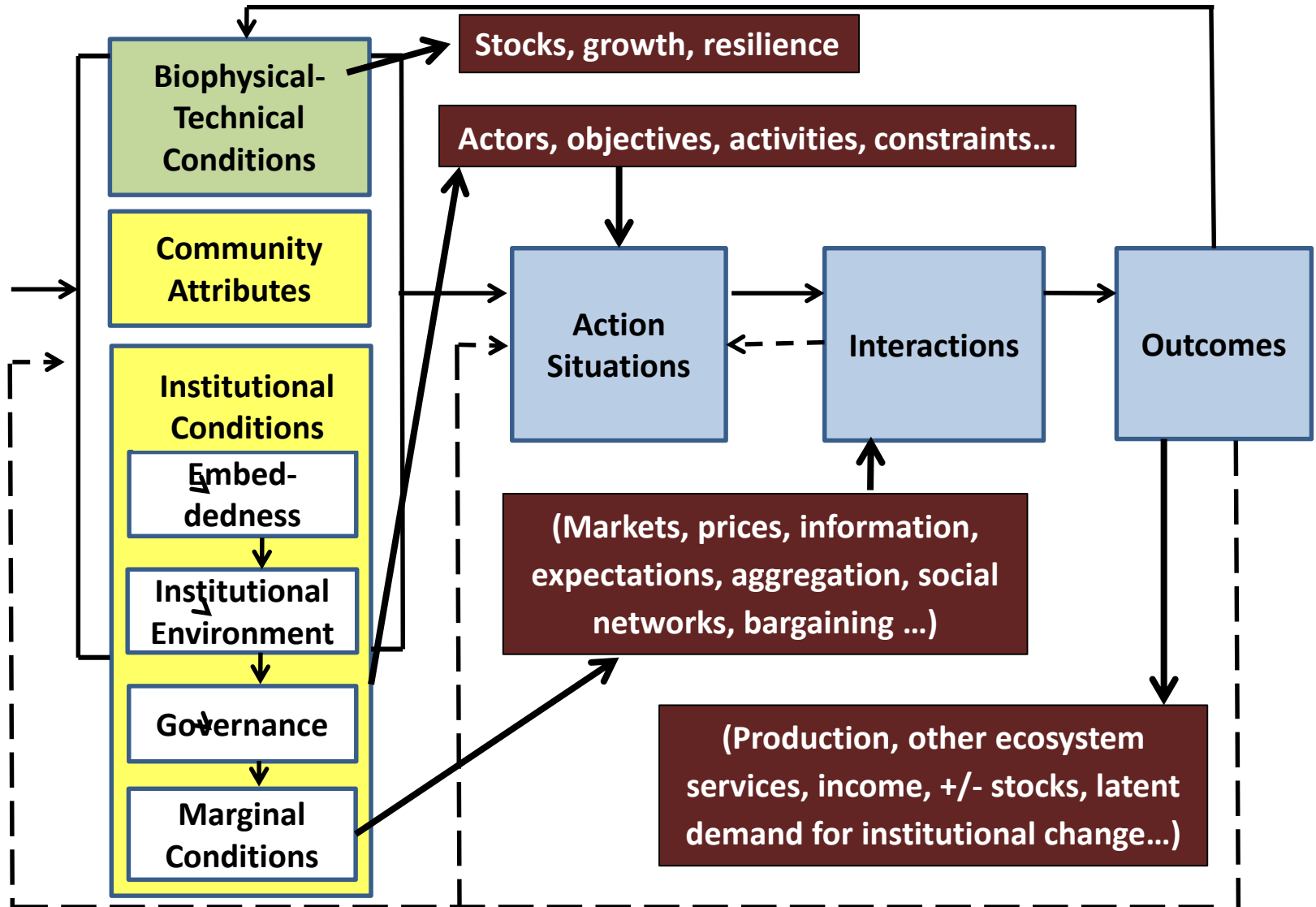


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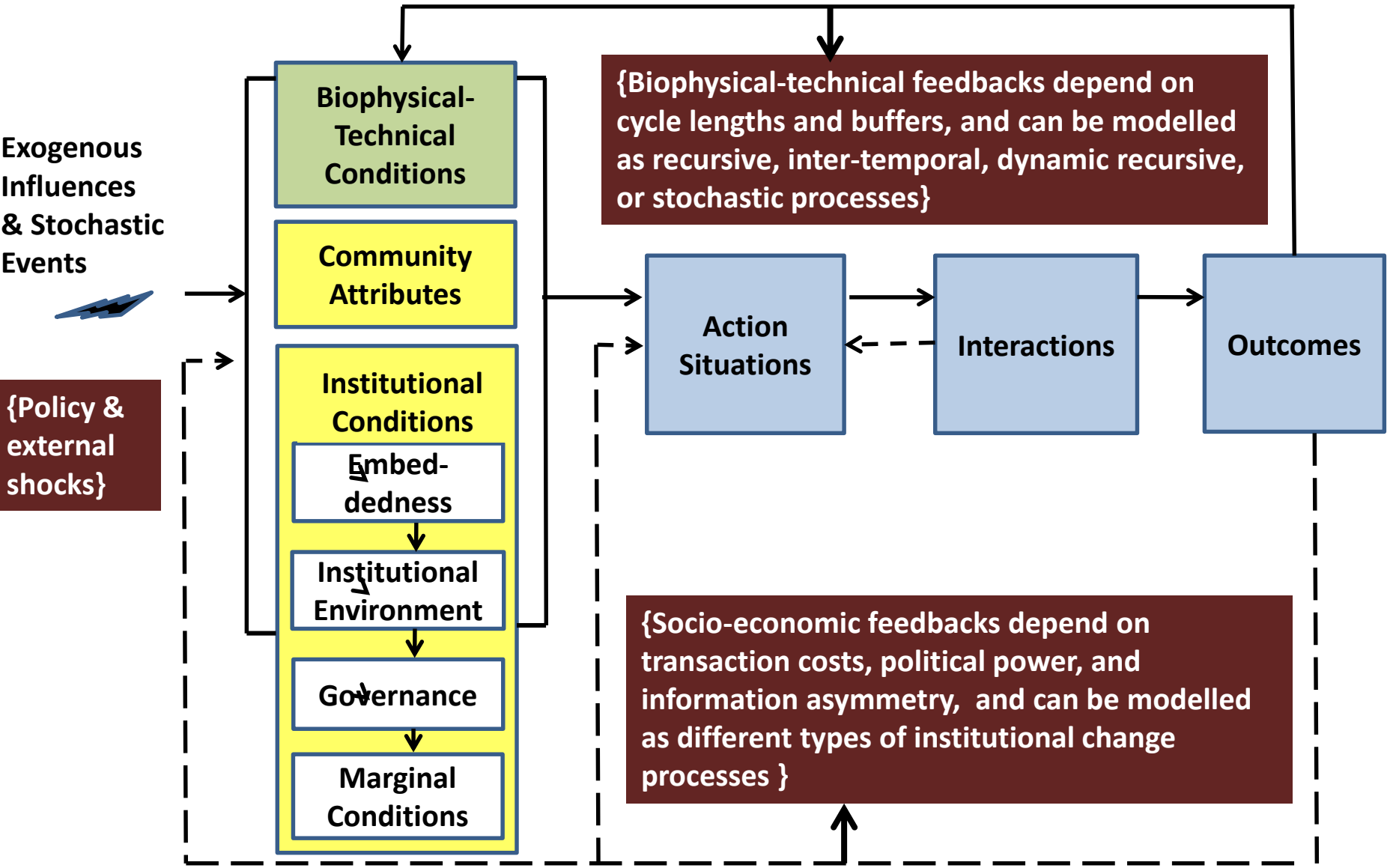


Table 2 Types of Bio-Economic Models & Institutions

Model Type	Pros	Cons	Applicability	Institutions
Optimization	Optimization Equilibrium	No Feedback (but, can discount)		Parameters Constraints
Bayesian Network	Models risk	No Feedback Limited heterogeneity	Discrete process Uncertainty X-sector linkages	Nodes Probability
Systems Dynamics	Inter-connections between sectors	No autonomy No adaptability/learning No evolution	X-sector linkages	Parameters
Evolutionary	Can adapt/learn Can evolve/Feedback	No autonomy	Long time scale	Parameters
Agent-Based	Interact/Autonomy Can adapt/learn Can evolve/Feedback Non-equilibrial	Maybe inconsistent theoretical underpinnings	Scaling-up X-sector linkages	Parameters Dependent variable

Table 3 Ex. of Explicit Integration of Institutions

		Example	Model Type	Depicting Institutions
G R O U P	HHs	micro-credit, Asia (Ngo & Wahhaj, 2012)	optimization	Intra-hh bargaining
	Collectives	rangelands, Africa (McCarthy et al., 2003)	empirical	strategic interaction
		Ind. / group PES on CA (Narloch et al., 2012)	experimental	Motivational crowding
	Networks	tech. diffusion, disease, endogenous networks & macro growth (Fogli&Veldkamp,2013)	evolutionary	Benefits & costs of networks
		targeted transfers, tech. adoption & poverty (Chantarat & Barrett, 2012)	optimization	Endogenous social networks
	Markets	irrigation, USA (Carey & Zilberman, 2002)	optimization	market interaction
		fertilizer pollution permits, Australia (Heckbert, 2011)	agent-based	fixed rule/marg. cond./hetr. inter.
	Property Rights	rangelands, Africa (Swallow & Bromley, 1994)	optimization	strategic interaction
crop-forest, Asia (Fernandez, 2006)		optimization	strategic interaction	
X-Sector Linkages	Irrigation, drinking water, shellfish, France (Mongruel et al., 2011)	systems dynamics	fixed rules	
	fertilizer, France (SEAMLESS-IF, van Ittersum, 2009)	IntFramework	n/a	
Policy thresholds	conservation, Australia (Whitten & Bennett, post 2004)	optimization	social choice	

institutions into bio-economic models

1. Hypothesis: institutions play important roles in defining existing and alternative contexts for interaction among agents



2. Use theory and / or evidence to depict how interactions are defined by institutions

(Game theory , social network theory, ethnographic research, experimental economics, expert opinion)



3. Develop conceptual model to generate hypotheses about effects of institutions or institutional change



4a. Collect data & test hypotheses empirically (survey or experiment)



5a. Policy analysis with validated statistical model



3b. Develop & specify empirical model, with some institutions fixed, others varying discretely (eg. $x = 0, 1$), others varying as parameters ($0 \leq x \leq 1$)



4b. Solve and / or simulate model and validate by comparison with reality and / or expert opinion



5b. Policy analysis with validated simulation or optimization model

Table 4 Modeling Approaches & Tradeoffs

Approach		Tradeoffs		Examples
Resource/Capital		Low complexity on I side frees up capacity for complexity on biophysical-technical side.	Simplification may decrease accuracy for policy guidance.	Chantararat & Barrett (2012) Fogli & Veldkamp (2013)
Constraint (Fixed-Rule)				Heckbert (2011) Mongruel et al. (2011)
Marginal Incentives				Heckbert (2011)
Structuring Interactions		High fit with reality increases accuracy for policy guidance.	High complexity on Institutional side may reduce capacity for complexity on biophysical-technical side.	
Market Interactions				Carey & Zilberman (2002) Heckbert (2011)
Strategic Behavior				Fernandez (2006) McCarthy et al. (2003) Narloch et al. (2012) Ngo & Wahhaj (2012) Swallow & Bromley (1994)
Interactions of Hetero. Agents				Heckbert (2011) Whitten & Bennett (post2004)

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Conclusions: Best Practice

- 1. Clarify Theoretical Foundations and Links between Theory and Practice**
- 2. Simplify Institutions into Constraints or Parameters**
- 3. Characterize Unobservable Behavior with New Tools (e.g., field experiments)**
- 4. Sustain and Integrate Modeling Efforts**



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